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Nuclear Decommissioning and Organisational Reliability: Involving Subcontractors in Collective Action

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INTRODUCTION

The concept of organisational reliability is at the heart of the safety of at-risk systems. Many studies have been conducted in the nuclear industry; all emphasise the study of plants in normal, daily operation or during shutdowns. However, decommissioning, whether ongoing or planned, places a sharp focus on the question. This is because, on the one hand operating companies make significant changes to their organisation to meet the challenges and requirements of decommissioning, on the other they must subcontract a large number of tasks related to the decommissioning. The use of subcontractors is not new; in the nuclear industry it became widespread in the 1990s and now represents more than 80% of activity [1]. However, the specificities of decommissioning lead to a re-examination of the overall organisation and the conclusion that subcontractors are a key player in its success.

The reliability of at-risk systems can be seen at play in collective action where the boundaries are drawn not only by the organisation itself, but also by the actors that compose it. Therefore an understanding of the overall logic of the organisation and its impact on safety issues requires subcontractors to be considered as full members of a modern organisation.

In this article, we first present the theoretical concepts of organisational reliability. Secondly, we describe the limitations of current models in relation to the specific role of subcontractors in the organisation. Finally, the third part looks at the measures necessary to integrate subcontractors into the organisation of decommissioning operations.

ORGANISATIONAL RELIABILITY AND THE NUCLEAR INDUSTRY

In 2004, Bourrier noted that it had become trivial to claim that the reliability and failure of systems are produced by the organisation [2]. However, she also highlighted that the definition of the organisation differs according to the discipline - it does not have the same meaning for ergonomists, psychologists or sociologists.

The aim of this section is first to revisit what is meant by the organisation as understood by organisational sociologists. We then briefly review some seminal studies on organisational reliability in the nuclear industry.

A sociological definition of the organisation

James Reason's appeal to organisational sociologists to better understand the organisational dimension of system safety [3] has been understood in different ways depending on the academic background of the researcher. The object in question is a composite and should be seen as at the intersection of several research issues. If we define organisational reliability as, "the study of organisational conditions that enables a complex organised system to maintain reliability levels consistent with both safety and economic requirements" (Bourrier, p.12) [2], then it is clear that the main purpose is as much to investigate errors caused by operators as to look for latent errors in systems that are the product of decisions taken at various levels of the organisation. Reason reminds us that while the active errors made by operators are known and well-documented, the same is not true of latent errors and in fact the situation is far from what is required [3]. Latent errors are hidden at various levels of the system and their unexpected succession can lead to catastrophes in industrial systems that were thought to be protected. The identification of

latent errors therefore requires immersion in the organisation in order to understand their hidden logic; something that cannot be seen from a direct reading of the official organogram.

The organisation is often defined as an architecture, which, with the help of a system of rules, constrains human behaviour in order to achieve the desired goal. However, this approach appears reductive to organisational sociologists. Although the sociology of organisations is a grouping of disparate organisational theories [4], they all seem to place the emphasis on interactions between actors that cannot be accounted for by managerial rationality.

Traditionally, for organisational sociologists (particularly strategic analysts) the “one best way” of Taylor [5] seen in the guise of Scientific Management does not represent the real relationships in the organisation. Strategic analysis sees the organisation as a construct that exists to bring people together in a cooperative relationship despite differences of interest. The aim of organisational research is therefore to try to better understand the mechanisms that enable individuals to cooperate in collective action. Two key books, “the actor and the system” from Crozier [6] and the “power and the rules” of Friedberg [7] provide the intellectual foundations for strategic analysis that is based on a triptych of power, games and strategy. According to strategic analysis, although the individuals in an organisation must take the rules into account, their choices are not necessarily prescribed by the rules. Rather, they are the result of strategies that individuals pursue to make best use of the resources and constraints of the situation they find themselves in. Moreover, the need for individuals to resolve shared problems is the origin of a set of power relations that structure relationships in the organisation. These relationships that can be seen on a sociogram¹ form the basis of the informal organisation, also called the real organisation. According to strategic analysis, only this auxiliary organisation merits research.

Organisational sociologists, notably Crozier and Friedberg [6, 7] encourage the investigation and

bringing to light of the real organisation on the basis of strategies pursued by its actors. While the rationality of decisions is very often measured in terms of the *homo economicus*, organisational sociologists prefer to think in terms of bounded rationality [8]. This approach, which has the effect of de-emphasising individual decision-making in favour of the organisational context in which decisions are made, significantly changes the knowledge that it is possible to have of organisations and makes it possible to anticipate the potential impact of interactions between actors on system safety.

This perspective helps us to understand how, independent of the context provided by the formal organisation the rationale of the auxiliary organisation as a whole can bring with it its own fragilities that weaken the defences of the system to the point where an accident occurs. Bourrier [9] goes further in the analysis, highlighting the relation between organisational conditions and the so-called informal organisation that is the fruit of deals done between actors.

The organisation and systems’ reliability: the nuclear sector

Approaches to organisational reliability have sometimes, for the most notorious incidents, led to post-accident studies. Among the seminal works, studies of systemic accidents such as the Challenger shuttle accident by sociologist Diane Vaughan [10], and the nuclear accident at Three Mile Island described by Charles Perrow [11] are pioneers.

However, to understand and bring to light latent errors that are found at various levels of the organisation, distant from operators who are in direct contact with the system, requires the observation of the organisation’s daily routine. This proposal was made by the Berkeley High Reliability Organization (HRO) group [12]. In contrast to the theory of the normal accident described by Perrow [11], which considers that every complex sociotechnical system is doomed to experience an accident, the HRO group put forward the hypothesis that some so-called high-risk organisations have established an organisational design and characteristics that enable them to maintain, despite extreme constraints, very high levels of human performance.

This desire to understand organisations that are subject to powerful political, technical and societal

¹ The sociogram is a schematic representation of the relations between actors that shows the alliances, conflicts, dependencies, etc. between them.

constraints made it possible to bring to light organisational characteristics that explain their high level of performance, without necessarily leading to the definition of a universal and transferrable model of reliability. Using a research methodology that is similar to that found in ethnography, this research also showed that to know the organisation, it is necessary to maintain a close relationship with its culture and mode of operation, classical analysis grids are not universally applicable to all organisations studied. This auxiliary nature of the organisation that is also characteristic of French-style organisational sociology [6, 7] has inspired a number of research papers in the field.

Among the most notable work is that of Bourrier [2, 9], who demonstrated a very clear link between the organisation and the reliability of nuclear power plants. In a comparison of American and French nuclear power stations during a shutdown, Bourrier made clear the relationships and the thought processes of actors while working on the system. A perfect example of a critical phase, the shutdown has stimulated the interest of researchers [13] in that the normal organisation of the plant is replaced by a temporary organisation. In this short timeframe, successive maintenance operations must be carried out by actors working under the pressure of strong economic constraints. In her analysis of nuclear power plants from the point of view of both deals done and organisational design, Bourrier argues that these various levels of analysis must be taken into account in planning system safety.

All these studies aspire to enrich theories of organisational reliability. They respond to the need to have a better understanding of “organisational ecosystems” [2] in order to design research methods that can account for the latent errors that lurk in systems.

However, all of the studies carried out in the nuclear sector have tended to focus on operational systems [14]. The next section therefore focuses on the organisational dimension of plant reliability during the decommissioning phase, paying particular attention to the role of the subcontractor.

ORGANISATIONAL RELIABILITY AND SUBCONTRACTING: DECOMMISSIONING

The expansion of subcontracting in the nuclear sector has been extensively studied both during

normal operations and particularly during maintenance operations. The situation is often described in the scientific literature as an oppressor-oppressed relationship in which the subcontractor is both the victim of risk outsourcing by the client and the primary source of failure [1, 15, 16].

Several French studies have made clear this level of dependence and stressed its negative impacts on occupational health and safety (Thébaut-Mony) [1]. The aim of this section on subcontracting is to first present the various forms of subcontracting found in the nuclear industry. Secondly, it highlights how subcontractors interact with the client's maintenance teams during scheduled shutdown operations. Finally, it shows that these relationships take a new turn in a decommissioning phase that takes place over a vastly longer timescale (up to several decades).

The various forms of subcontracting

It is customary to confine subcontracting to its legal definition, “subcontracting is the operation by which a business through a subcontract, and coming under its responsibility, gives to another person called a subcontractor the execution, in whole or in part of the contracted business or part of a public contract concluded with the client” (unofficial translation of French *Loi de 1975, article 1*) [17].

The subcontractor, by extension, is often considered to be placed in an insecure position by a contract that gives supremacy to the client. However, there is not one monolithic form of subcontracting. It can be looked at under a classic typology that takes into account different forms that are based on business needs (specialty and cascade subcontracting for example). It can also be examined using a “spatial” approach that distinguishes between *in situ* sub-contractors (who carry out work on the client's premises) and those who operate on their own premises. In the case of the nuclear industry, it is the former that interests us if we want to understand their relationship with the client organisation's various services. Rather than their legal status, it is the nature of the relationship that the subcontractor has with the client that is relevant [18]. The next section outlines the role played by subcontractors during shutdowns.

Subcontracting and shutdowns

Subcontracting in the nuclear sector has raised many questions concerning the motivation of the client to outsource risk. It has often been analysed as a desire to resort to an insecure workforce in order to respond to competition in the sector. Shutdowns symbolise this sense of domination. In a timeframe that gets shorter and shorter the nomadic workforce is obliged to work to a very tight shutdown schedule. The urgency of the shutdown and the fact that it has a management mode that is different to normal plant operations reinforces this sense of domination. The particularities of the sector, where time spent on a task is directly related to adverse effects on occupational health and safety has also had the effect of creating doubt about whether the real intention of the operator might be to avoid exposing its own employees and instead outsource tasks considered dangerous for workers.

More generally, outsourcing may have a potentially negative impact on plant safety. A French parliamentary report [19] underlined the potential risks to system reliability of using subcontractors. According to the report, in resorting to the wholesale use of subcontractors, operators both water down their responsibilities and run the risk of not fully understanding the true skill-level of the actors who carry out interventions. In some cases, it is possible to find a cascade of subcontractors, which makes it impossible to be certain that the entire chain consists of workers who are actually trained to carry out the required tasks.

This opaque relationship between client and subcontractor together with the particularities of the sector therefore has a certain bearing on the judgements that come into play during operations. Both the employees of the subcontractor and those of the operator should have an opinion of each other that reflects their professional identity and hierarchical position. However, in the nuclear industry, subcontractors cannot be reduced to the stereotypical image of the nomad worker that is often associated with them [13]. On the other hand, it is clear that the systematic use of subcontractors has changed the role and mission of the operator's employees, who no longer do work themselves but instead arrange to have it done. The growth in subcontracting has led to changes in how shutdowns are organised. Currently, a temporary management unit dedicated to the shutdown has to be created and preparations have

to be made well in advance in order to be able to hand over control to subcontractors.

This control, which must take into account both the budget for the shutdown and task planning, determines the organisation of the plant during the shutdown. To achieve the shutdown objectives, an interface must be created between the plant's employees and those of the subcontractor that is mediated by the project and works manager.

Project managers are responsible for organising the work of subcontractors, while works managers must check that the planned work has actually been carried out on the ground. The organisation of work according to what is written down still leaves room for local deals that diverge from what has been prescribed. As Bourrier wrote, "Despite the necessary preparation of schedules, until work begins the hourly timetable of those responsible for carrying it out is not known. However, service providers have an absolute need to know exactly when they should arrive, and especially how many free weekends they can expect, so that they can return to their families" (Bourrier, p.163) [9]. This need to organise themselves therefore leads subcontractors to make tacit deals with the project and works managers. It is very likely that these deals can be found at other levels in the subcontracting chain and also that they do not come to the attention of planners or the shutdown manager. These grey areas then form the basis of the informal organisation described by a strategic analysis, which it is necessary to be familiar with and analyse in order to truly know the real organisation.

The informal organisation therefore constitutes the field of investigation. The everyday realities of the shutdown are not reflected in its official version. Oppressed workers may not be those who they first seemed. The operator's employees are under pressure during the shutdown and service providers are necessary to meet the demands of the market and fulfil orders. Subcontractors are used to working on different systems; therefore they have both technical expertise and are accustomed to working with clients. Moreover, they have a good understanding the technical and organisational constraints of the operator and can pursue strategies that preserve their independence. This power that they have over the organisation gives them a certain degree of autonomy that can have a bearing on the reliability of the system as defined by procedures.

A short-term shutdown does not necessarily challenge collective action that, as the various stoppages progress is focussed on two outcomes: for the subcontractor, carrying out the required work and for the operator, ensuring the resumption of operations as quickly as possible. Joint shutdown preparations, drawn up well in advance allow service providers and clients to plan the tasks to be carried out in detail, taking into account the requirements of both parties [20].

The following section shows that decommissioning, throughout its duration, does not follow the same pattern as the shutdown. Although the parties involved in decommissioning may look like the two types of organisation, the timeframe is much longer, which changes the relationship between the actors.

Subcontracting and decommissioning

When a plant is to be decommissioned, there are constant references to the shutdown. This reference is directly linked to the hiring of large numbers of service providers. However, the relationship to time changes as decommissioning takes place over a period that makes it difficult to foresee all the operations to be carried out. This opaqueness in planning and the need to improvise that are inherent in this new phase of the plant's life reinforce differences in the information available to stakeholders

It is also necessary to note that decommissioning is traumatic for longstanding actors at the plant, who see in it the "death of the system" and the deconstruction of their working tool. Decommissioning that follows a period of intense activity turns the existing organisation upside down. The organisation, which had previously dedicated itself to operations, must now re-orient itself to decommissioning with all the symbolism that that entails.

The case of the decommissioning of the Superphénix plant in France is symptomatic of this situation. Research carried out from an anthropological perspective highlighted the symbolic death of the plant and its impact on employees, "Those who worked at Creys-Malville had to mourn the loss of their magnificent tool. To soothe their psychological wounds, they created an amazing memorial for Superphénix, we carried out a symbolic burial with a real headstone, one of them says. The stone is still there, stuck in the ground near one of the entry gates" [21]. It is

essential to understand this aspect of decommissioning to appreciate the state of mind of the operator's employees when work is carried out. Although the situation is very different depending on whether the decommissioning is the result of a sudden political decision (such as the one that led to the shutdown of Superphénix) or whether it is the result of a programmed decision (as was the case at the Phénix plant, also in France) the decision has serious implications for all workers. It has two main consequences. The first is the challenge to the formal organisation and the implicit hierarchy that exists between operations and maintenance services. The second is the challenge to the informal organisation that is based on the deals made between actors who were trying to keep the plant working.

The effect of a modification to the formal organisation is to give preeminence to maintenance services. Supervision remains the guarantor of system safety, but the final objective is very much decommissioning. This modification of the formal organisation that is accompanied by a reduction in the number of staff at the plant and widespread subcontracting therefore leads actors and services to acknowledge a change in professional identity and to shift into a known operating phase, i.e. the shutdown. Repeated references to the shutdown then become synonymous with the relationship that links the plant's employees with service providers.

The second modification relates to the informal organisation. This plays a role in the loss of information and in the day-to-day deals that enable the plant to operate, independently of formal operating procedures and contractual relationships that link it with service providers.

Moreover, these changes must coexist in a relation to time that is very different to that of normal operations. In the day-to-day functioning of the plant, time compresses under production constraints. A symptom of these economic constraints is that shutdown periods have become shorter and shorter over the past 20 years. As the previous section noted, the shutdown order requires the actual shutdown to be planned well in advance. A successful shutdown must be planned and prepared up to six months before it actually happens. The manager who coordinates the shutdown can be compared to the conductor of an orchestra; a role that enables them to mobilise all participants. Deals may be made, but they are often known by everyone concerned.

In the decommissioning phase, time slows down. In the context of the Superphénix decommissioning, Berger [21] noted that the sense of time changed, “Bring back our silent clocks that show suspended time, decommissioning time, like the half-life of radioactive materials that are stored while waiting for the radioactivity to naturally decay. Talking about the decommissioning in terms of half-life is a good description of the programmed death of the site.”

Decommissioning constitutes a new and unknown phase for plant actors and is therefore the origin of a new type of risk linked to human and organisational factors. This aspect, examined in detail in an *Institut de Radioprotection et de Sécurité Nucléaire* (IRSN) report [22] emphasises the need to take specific account of subcontractor activities during the decommissioning operation. The IRSN report focuses on risks related to radioprotection that have an impact on workers. It also examines concurrent activities, which can have a significant impact on both the safety of employees and the plant. The IRSN report argues that risks associated with human and organisational factors must be treated with the same rigor during decommissioning, as during the operational phase.

Decommissioning creates a new reality for the actors at the plant that translates into significant adjustments at all levels of the organisation. The reorganisation of services implies that all actors must take ownership of the challenges of decommissioning and develop a perspective of time that is not that of the shutdown and no longer that of production but is that of decommissioning.

The nature of the relationship between the operator’s employees and subcontractors also changes. Although the supervisory services of the operator remain the guarantor of the safety of the installation and therefore the issue of intervention orders, it is clear that maintenance services take precedence over other services. This change in the power structure at the plant means that maintenance services who manage contracts with subcontractors find themselves face-to-face with external companies. The pressures of economic constraints weigh heavily on decommissioning and action is guided by their economic and technical objectives.

The project manager is reminded on a daily basis of the economic pressures that dominate the phases of the final shutdown and actual decommissioning. Although plant safety is

paramount during the decommissioning, the use of specialised decommissioning companies can lead to a feeling of loss of control over what is happening on the ground. Unlike the shutdown, which is planned well in advance and where the modes of adjustment are well-known, decommissioning requires adjustments over a longer period and dealing with an operational context that is constantly changing.

The interface between employees of the operator (who suffer the effects of the reorganisation following the shutdown) and employees of subcontractors (who take control of the plant to carry out the major phases of the decommissioning) can therefore create a sense of loss of control for the operator’s employees and a large grey area for subcontractor’s employees. Differences in what information is available then acts in the favour of sub-contractors who can impose their own planning constraints independent of the operator’s planning for the project [23].

The principal risk in this context is that the planning unit set up by the operator is not able to understand the reality on the ground and the operator senses a loss of control. This is characterised by slippage in the schedule for reasons that are not obvious to the operator. In this situation, it is necessary to look again at the relationship between the client and subcontractors in order that the organisational dimension of the project does not interfere with its coherence execution.

RETHINKING THE ROLE OF THE SUBCONTRACTOR

Subcontracting in the nuclear sector, as in other industrial sectors leads to a very direct re-examination of the question of the definition of the organisation. Should the relationship with subcontractors be analysed from an inter-organisational perspective or should the subcontractor be considered as one of the organisation’s own actors? This section presents two possible responses to this question and looks at their effects on system safety.

First, the relationship between client and subcontractor is considered in terms of a strictly contractual relationship. Secondly, the subcontractor is considered to be an actor in an extended organisation.

The client/subcontractor relationship: The risks of a strictly contractual relationship

Although this article discusses subcontracting in the nuclear industry and specifically, during decommissioning, it seems useful to make an anthropological detour via the aerospace sector and a well-known accident in order to gain an insight into the dynamics of the client/subcontractor relationship and their consequences for decision-making.

Diane Vaughan in her book on the Challenger shuttle accident [10] pointed out that during the programme NASA had favoured a bureaucratic culture, to the detriment of the technical culture of NASA engineers. Although the technical culture still existed, engineers were forced to make compromises in order to follow the rules as they were so busy with their administrative tasks. "Production constraints censored intuition and the subjective concerns of individuals that were so important in the organisation of research and development during the Apollo period. Finally, the bureaucratic reporting procedures unexpectedly contributed to the normalisation of deviance. (...) They believed that by respecting all these rules and procedures they were doing everything in their power to ensure the safety of the shuttle". (Vaughan in Bourrier, p. 215) [2].

Subcontracting was a feature of the Challenger program, as was respect for very complex rules intended to ensure the reliability of the shuttle. History has shown however, that the trade-off between contract management and strictly technical decisions acted against the reliability of the shuttle.

In the context of organisational changes due to decommissioning, the shift from doing things yourself, to arranging for things to be done requires the management of contracts and in some cases, relegating technical issues to the background. The need to deal with administration at the expense of skills and technical discussions about the operations to be performed distances the subcontractor and confines them to the role of interlocutor in a contractual relationship. However, subcontractors working on decommissioning activities operate in a very grey area that is on the one hand the consequence of their own competence that has been acquired on different sites and on the other, their deep understanding of the domain. Seen from this perspective, maintaining a solely contractual

relationship leads to the marginalisation of a key actor in the organisation.

The client/subcontractor relationship: Rethinking the boundaries of the organisation

The question that then arises is how to redefine the boundaries of the organisation so that the interactions between service providers and operators can be understood in terms of a strategic analysis. These interactions and the underlying challenges effectively determine the real organisation.

When analysing the relationship between clients and subcontractors, it seems appropriate to focus on communication between the actors. The strategies and communication methods used by the subcontractor in the context of its contractual relationship provide a better understanding of the modalities of cooperation and joint regulation [24] in the decommissioning organisation. The literature clearly describes the strategies of corporate networks who try to control their subcontractors [25]. However, these studies emphasise the relational investments between the two companies that must cooperate. Subcontractors are encouraged to strengthen their partnership with their clients by market pressure and competition.

In the context of decommissioning there is sometimes a genuine partnership between companies and project managers. However, regulations governing the relationships between corporate clients and service providers limit the extent of the partnership and lead actors to find opportunities for dialogue and discussion that go beyond traditional organisational boundaries.

There is a need to find common ground that goes beyond the informal competition/cooperation relationships that develop between subcontractors and between subcontractors and project managers. A French law, passed in 1990 [26] significantly altered the relationship between the employees of the client company and the employees of the subcontractor. The need to respect the autonomy of the subcontractor gave rise to an obligation of non-interference that applies to the client company. The effect was to improve the interface between teams working on the same site. In these conditions, opportunities to discuss the actual work being carried out remain rare. The difficulty of updating management tools for consignments and the issue of intervention orders is a symptom of this state of affairs. Tensions generated by a lack

of information can lead to decisions being taken that may have consequences for system safety. Unwanted concurrent activity is a typical example of this.

Rethinking the role of the subcontractor therefore aims to both make them a partner while at the same time remaining aware of the contract that governs the relationship. The subcontractor is in a position that obliges them to meet the requirements of the contract they signed with the operator; however they should not be seen as the victim of an oppressor. Their decommissioning expertise means that they are equipped to respond to the objectives of the operator. It is up to the operator to put in place measures that support the expression of this partnership.

So far, this seems to be the only way to foster interactions that can create shared meaning in order to successfully carry out a complex operation whose timeframe may seem very distant to stakeholders.

CONCLUSION

Subcontracting in the nuclear industry has provided material for a great deal of research both during normal operations and in the decommissioning phase. However it requires special attention in the decommissioning phase. Although it is analogous to a shutdown, decommissioning is very different. On the one hand, it leads to a reorganisation of the operator, which has consequences that are likely to affect the initial level of reliability of the organisation. On the other hand, it takes place over a very long period of time and requires unfamiliar techniques. Prior planning for the shutdown immediately runs into the problem of a moving time horizon that makes it very difficult to anticipate when external companies will be required to intervene. The second difficulty relates to the sense of loss of competence and knowledge of the field. An evaluation of organisational reliability must take into account the distance between the organisations's various actors and consider the subcontractor to be a full member of the organisation in the sense of a strategic analysis. From this perspective, relationships between the client and the subcontractor are no longer dependent but are based on strategies that necessarily lead to alliances and partnerships. An understanding of the organisational challenges that are specific to each system involved in

decommissioning makes it possible to limit uncertainties that influence system safety.

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